

## **An Experimental Mode of Radar Operations during the SRTM Mission**

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This paper describes an experimental mode of radar operations executed toward the end of the Shuttle Radar Topography Mission (SRTM), a mission using a fixed baseline interferometric synthetic aperture radar (IFSAR) to acquire data for creating a global digital model. The paper compares the experimental mode with the baseline mode of operations, which was used nearly exclusively during the mission. The potential advantages of the experimental mode over the baseline mode are discussed with some preliminary results. The advantages, if validated, could benefit radar design for future missions or a re-flight of SRTM.

### ***SRTM Baseline Mode of Radar Operations***

Given SRTM's requirement of achieving global data acquisition over land in an 11-day mission, the radar needs to operate in ScanSAR to obtain single-pass swath coverage of  $\geq 225$  km. Four sub-swaths are required with the given antenna beam-width and other technical considerations. Instead of using a single beam to scan across the four sub-swaths, a pair of beams (H-pol and V-pol) would illuminate two different sub-swaths simultaneously and be scanned in succession, allowing the beam pair to dwell twice as long as allowed for a single beam. This dual-beam (simultaneous two sub-swaths) scanning would improve the number of looks attainable in azimuth.

The echo from the sub-swath illuminated by the H-pol beam would contain both H- and V-pol signatures from the target (designated as HH and HV, with the first letter designating the transmit polarization and the second letter the receive polarization). However, since the V-pol receive beam is pointed to a different sub-swath, only the HH (co-pol) signal is captured by the H receive beam and the HV (cross-pol) signal is ignored. Likewise, only the VV signal is captured and VH signal ignored of the echo due the V-pol illumination.

There are four receiver channels in the SRTM radar system; two configured to receive the inboard echoes and two for outboard echoes. The radar signals captured by these four receiver channels are as follows:

- Channel 1: VV-outboard
- Channel 2: HH-outboard
- Channel 3: HH-inboard
- Channel 4: VV-inboard

Channel 1 and channel 4 form an interferometric pair of data sets, and channel 2 and channel 3 form another. The scanning SAR operation multiplexes in time the data acquired over two different sub-swaths in each channel. Considering the inboard channels, channel 3 would contain signals from two sub-swaths interspersed in time and channel 4 the other two of the four requisite sub-

swaths. This baseline mode of operations was the basis of SRTM design and implementation and was used throughout most of the mission.

### ***Experimental Mode of Radar Operations***

Shortly before the mission and after the flight hardware and ground system were ready for the mission, a new radar configuration was contemplated, which under some circumstances, could potentially enhance the data products. Although the new configuration fit within the designed capabilities of the existing system, it was not considered for mapping operations because of insufficient testing with flight and ground planning systems.

This experimental mode differs from the baseline mode configuration in two aspects: (a) although it also transmits two polarization beams simultaneously, the H- and V-pol beams are pointed at the same sub-swath; (b) the composite beam is scanned over the four sub-swaths as a single beam. Since each receive channel can capture only one polarization, the polarization signature of echo in the four receiver channels becomes:

- Channel 1: (H+V)V-outboard or (HV+VV)-outboard
- Channel 2: (H+V)H-outboard or (HH+VH)-outboard
- Channel 3: (H+V)H-inboard or (HH+VH)-inboard
- Channel 4: (H+V)V-inboard or (HV+VV)-inboard

Again, channel 1 and channel 4 form the interferometric pair of data sets and channel 2 and channel 3 form another. The scanning SAR operation multiplexes the data acquired in time when scanning over the four sub-swaths.

### ***Comparison of Baseline Mode and Experimental Mode***

The table below compares the differences of these two modes of operations:

	Baseline Mode	Experimental Mode
(a) Signal Strength	Capture only co-pol signal	Capture co-pol and cross-pol combined
(b) Topographic Mapping	Four channels to get full four-sub-swaths for a single topography map	Two channels for full coverage at reduced looks, four channels for simultaneous independent observations
(c) Intensity Mapping	Two sub-swaths are in VV and 2 sub-swaths in HH	All four sub-swaths are the same polarization, (HH+VH) and (HV+VV)
(d) Dwell time	Equivalent to 2 sub-swath scanning, longer dwell time	4 sub-swath scanning, shorter dwell time

With the exception of (d), which reduces the dwell time and consequently the attainable number of looks, items (a)-(c) seem to indicate that the experimental mode will yield better products and is more resilient to failure. It also appears that the height degradation due to reduction in dwell time (d) can be compensated by having stronger signal strength (a) and two independent height measurements (b).

The experimental mode was executed toward the end of the mission, when all critical data acquisition had been completed using the baseline mode and the mission objectives were met. Instead of executing the experimental mode directly, a series of slightly different configurations were executed through manual planning. Preliminary images and height data from these data takes will be presented and compared to those from the baseline mode of operations.

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